Cohen (J. Sol.)

The Use of Compressed and Rarefied Air, as a Substitute for Change of Climate, in the Treatment of Pulmonary Diseases.

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THE USE OF
COMPRESSED AND RAREFIED AIR, AS A SUBSTITUTE FOR CHANGE OF CLIMATE,
IN THE TREATMENT OF PULMONARY DISEASES.*

By J. SOLIS-COHEN, M. D., Etc.
PHILADELPHIA.

THE great desideratum in exiling *poitrinaires* is to secure to them an opportunity of being in the open air, so that their lungs shall have a proper respiratory diet. Such pabulum, taken naturally, is far superior to any artificial administration. But, for the benefit of individuals whose lack of money or whose domestic duties preclude their resort to a temperate climate, there is a substitute in periodic inhalations of air subjected to modifications of pressure. In many cases fully as much good can be secured by this treatment as by change of climate, and in a few much more; though, in the vast majority of cases in which change of climate is advisable, it is but a poor substitute. Its efficacy, however, has never been appreciated in the United States, although fully recognized in Europe, especially on the continent.

For some twenty years I have made occasional resort to this method of treatment as suitable cases presented; but special lines of practice have so closely occupied time and thoughts that the method has never been pushed for the purpose of attracting patients, while little has been contributed by me to the literature of the subject, save that written in the two editions of my "Treatise on Inhalation" (Philadelphia, 1867 and 1876).

The time required for the proper administration of an inhalation of compressed or rarefied air—from twenty to thirty minutes—is too great for a busy practitioner to bestow daily, or twice a day,

* Read before the American Climatological Association, May 5, 1884.

upon individual patients; and it is only by massing patients, and having them inhale simultaneously from a number of apparatus, that this department of practice can be rendered sufficiently remunerative to attract careful supervision. Hence it is mainly confined to institutions fitted up for the purpose, and has not become incorporated into private practice. Patients whose means permit them to purchase apparatus for their own use can be instructed how to take their inhalations at home; and the method of treatment will begin to receive the professional attention it merits whenever apparatus of moderate cost can be supplied for this purpose. Hitherto the apparatus constructed with this view have been too costly and too cumbersome. An approach to a suitable contrivance for inhaling compressed air has been made in my own office by the combined efforts of my brother, Dr. Solomon Solis-Cohen, and Mr. Charles Richardson, physicist in Queen & Co.'s establishment, Philadelphia.

This apparatus, like that of Waldenburg and some others, utilizes the gasometer principle—a principle which years of experimentation with different methods have convinced me is the best adapted to the purpose. By weighting the inner cylinder (air-chamber) at the bottom, accurately adjusting its diameter to that of the outer one (water-chamber), and pumping the air into it by means of a foot-bellows, the cumbersome arrangement of ropes and pulleys is done away with, and the size of the machine considerably reduced. One of these instruments (Fig. 1), which has been in office use more than six months, consists of an inner hollow cylinder 12 inches in diameter and 20 inches* high, open at the bottom, but having two shelves, as it were, upon which to rest the weights—as if the cylinder had been covered in, top and bottom, and a longitudinal strip cut out of the middle of the base. The outer cylinder, open at the top, is just enough larger than the inner cylinder to enable the latter to slide up and down in it without grooves or flanges upon either. A rim upon the inner cylinder prevents it from sinking quite to the bottom of the water-chamber—a preservative device. A tank to catch the water displaced by pressure is placed around the outer cylinder, reaching about half way down, and communicating with the cylinder by means of a row of holes bored in the cylinder at the level of the base of the tank. The diameter of the upper rim of the tank is 16 inches. A line painted on the outer cylinder indicates the

* A machine 18 inches high can be used; one 24 inches high will give better mechanical results.

water level, and a line painted on the inner cylinder indicates how high it may be pumped without being thrown out of the water. Both of these points, while susceptible of calculation, are conveniently ascertained by experiment with the highest pressure intended to be used.

The weights are of lead, segments of circles in shape, so as to assist in maintaining the equilibrium of the inner cylinder. A very simple calculation will give the proper weight for every fraction of an atmosphere intended to be used.* Thus, with an air-chamber of 12 inches diameter, upon which there is an atmospheric pressure of about 1,696·50 pounds, we should need, in round numbers:

For $\frac{1}{70}$ of an atmosphere, $24\frac{1}{4}$ pounds.
For $\frac{1}{60}$ " " $28\frac{1}{2}$ "
For $\frac{1}{50}$ " " 34 "
For $\frac{1}{40}$ " " $42\frac{1}{2}$ "

The inner cylinder weighs a little over four pounds. Placing on its shelves twenty pounds, we augment the pressure by $\frac{1}{70}$ of an atmosphere, and the additional weights are placed atop of it as required. A gauge may be attached at a slight additional expense; but it is unnecessary, as the pressure is verified by the manufacturer before delivery of the apparatus. Of course, the top of the inner cylinder is pierced with two holes, into which are fitted two goose-necks—one for the attachment of the tube from the bellows, the other for the attachment of the tube to the stop-cock and mouth-piece—Waldenburg's being at present employed in the absence of a better form. The water may be run in through either of these pipes, and drawn off by means of a stop-cock at the bottom of the outer cylinder. When it is desired to cleanse the apparatus, the inner cylinder may easily be lifted out. The expense of the gasometer, weights, bellows, and tubing is in the neighborhood of twenty dollars; but the manufacturers think that, if sufficient demand exists to warrant making the apparatus in quantity, this figure can be reduced to fifteen dollars. The accompanying diagrams will render the description of the apparatus clearer.

The immediate effect of *inhaling compressed air* is to dilate the lungs and thorax to a greater extent than can be accomplished by the deepest possible voluntary inspiration at the ordinary pressure. The inspiratory portion of the respiratory act is thus greatly facilitated. To avoid rupture of the air-cells, it is not safe, especially with

* This has been ascertained by experiment to be the best size.

invalids, to employ a greater pressure than from $\frac{1}{80}$ to $\frac{1}{60}$ additional atmospheric pressure at first, gradually increased to $\frac{1}{40}$ or $\frac{1}{30}$. The $\frac{1}{30}$ additional pressure need never be exceeded. This method of

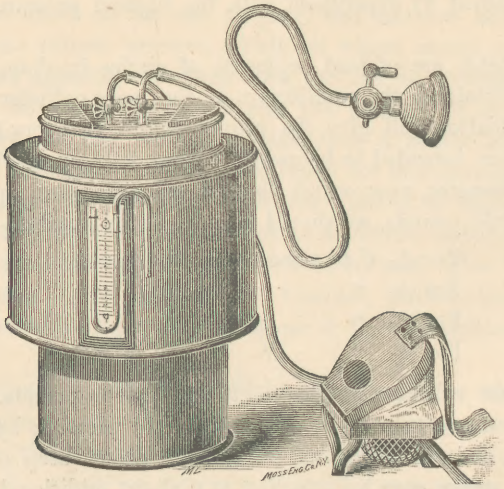

FIG. 1.—Cohen and Richardson's Compressed Air Apparatus.

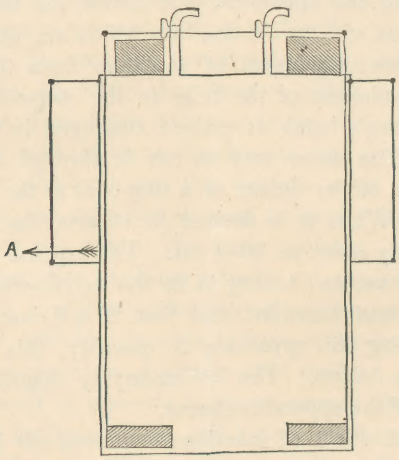

FIG. 2.—Section showing the method of weighting the inner cylinder. At the level of the arrow, A, a row of holes is bored through the outer cylinder to permit the escape of water.

treatment is indicated in early phthisis, in chronic bronchitis, in the partial collapse of lung sometimes following pneumonias, and, in fact,

in all cases in which it is desirable to augment the vital capacity of the lungs, except in those instances where there exists a strong disposition to hæmorrhage. As the increased pressure on the intrathoracic organs increases the general intravascular pressure, it is easy to understand that such treatment is imprudent in individuals disposed to hæmoptysis, hæmatemesis, epistaxis, hæmorrhoids, or other blood-loss.

The immediate effect of *expiration into compressed air* is to impede that portion of the respiratory act. This will tend to dilate the air-cells and rectify collapsed lung by backward pressure, so to speak, thus accomplishing the same results as inspiration of compressed air. The only advantage gained is in the muscular effort necessary to breathe into compressed air, and this can be well utilized in cases in which it may be an object of importance to increase the power of the respiratory muscles by systematic gymnastic exercise. For weak patients the method is unsuitable. Tendency to hæmorrhage is a contra-indication for the process.

The immediate effect of *inspirations of rarefied air* is by diffusion to tend to diminish the pressure of the air in the lungs. The greater pressure of the atmosphere externally is demonstrated by recession of the intercostal parietes, and of the soft parts above and below the sternum. The method thus acts as a gymnastic exercise for the muscles of respiration. The special therapeutic effect approaches that produced by residence at high latitudes, for which in certain cases it may prove an acceptable substitute.

The immediate effect of *expirations into rarefied air* is to exhaust a portion of the residual air in the lungs and thus favor the collapse of the distended air-cells. The indication for the practice of the method is found in asthma and in pulmonary emphysema. And here I believe the home treatment by apparatus is often more efficacious than change of climate.

Had the pressure of other duties permitted, these remarks would have been extended, and the value of the various plans of treatment would have been illustrated by the records of typical cases. Even in the study of pulmonary diseases alone, we need to consider the effects, both immediate and mediate, upon the heart and circulatory system in general, produced by the use of these methods. The systemic effects, too, such as increased appetite and improved digestive powers, in some cases of phthisis, deserve a modicum of attention. But the writer's object has been accomplished in simply recalling attention to a neglected therapeutic art, in the hope that some of

those present, or some of those who may read the report of the papers presented at this meeting, may be incited to study the subject more thoroughly.

It may be added, in conclusion, that auscultation and percussion during respiration of air subjected to compression or rarefaction bring out in relief special phenomena obscure or doubtful under the ordinary methods of auscultation and percussion, while some sounds are evolved which otherwise escape detection altogether.

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